

## CLAIMS

»»» We ««« claim:

1 1. A data storage apparatus for fulfilling read and write requests from a  
2 computer comprising:

3 a solid-state cache memory;

4 a storage element with at least one moving part wherein the storage element  
5 has an operating mode, and a non fully operating mode when data access has not  
6 occurred for a predetermined time period;

7 a cache control system responsive to read and write requests from the  
8 computer, said cache control system further comprising,

9 means to access data stored on the storage element if a read or write request  
10 cannot be satisfied via access to the cache memory; and

11 a cache replacement mechanism for transferring data between the cache  
12 memory and the storage element to maintain consistency of data between data stored  
13 in the cache and data stored in the storage element, wherein the cache replacement  
14 mechanism performs data transfers between the cache memory and the storage element  
15 when the storage element is at operating speed after a read or write request requires an  
16 access to the storage element.

1 2. The data storage apparatus of claim 1 wherein the cache replacement  
2 mechanism carries out transfers <sup>of new data</sup> from the cache memory to the storage element for a  
3 predetermined time each time a read or write request has given rise to an access to the  
4 storage element.

1           3.     The data storage apparatus of claim 1 wherein the cache control system  
2 further comprises means for accessing the data on the storage element without  
3 modifying the data in the cache memory if the read or write request involves more  
4 than a predetermined amount of data.

1           4.     The data storage apparatus of claim 1 wherein the data is arranged in  
2 sectors, the cache control system further comprising means to identify a set of sectors  
3 within the cache memory and associated with each sector, wherein the cache  
4 replacement mechanism transfers all members of the associated set of sectors from the  
5 storage element to the cache memory when a read or write request has given rise to  
6 the sector being read from the storage element.

1           5.     The data storage apparatus of claim 4 wherein the cache control system  
2 further comprises:

3                 means for identifying the sectors in the cache which contain information  
4 fresher than the corresponding sectors in the storage element; and

5                 means for transferring to the storage element sectors in the cache which contain  
6 information fresher than that stored on the corresponding sectors in the storage  
7 element in response to a read or write request having given rise to an access to the  
8 storage element.

1           6.     The data storage apparatus of claim 5 wherein the means for  
2 transferring to the storage element sectors in the cache which contain information  
3 fresher than that stored on the corresponding sectors in the storage element, transfers  
4 the sectors in non-increasing order of the current time minus the most recent time that  
5 any sector in the group of sectors associated with the sector was accessed.

1 7. The data storage apparatus of claim 4 further comprising:

2 means to identify, at any particular time, the sectors that have been accessed in  
3 a preceding predetermined time interval; and

4 means to update the set of sectors in the cache and associated with a sector,  
5 when a read or write request has given rise to the sector being read from the storage  
6 element, by adding a historical reference to the sectors that have been accessed in the  
7 preceding predetermined time interval.

1 8. The data storage apparatus of claim 7 wherein the means to update the  
2 set of sectors determines whether each sector in the associated set of sectors has been  
3 accessed in the preceding predetermined time period and removes the sector from the  
4 set after determining on a predetermined number of occasions that the sector has not  
5 been accessed in the preceding predetermined time period.

1 9. The data storage apparatus of claim 4 further comprising:

2 means to determine and store an indication whether each sector in cache  
3 memory was accessed on the most recent one or more occasions when it was brought  
4 into the cache, wherein the cache replacement mechanism transfers a sector from the  
5 storage element to the cache memory when a read or write request has given rise to  
6 the sector being read from the storage element responsive to the sector being accessed  
7 on the most recent one or more occasions.

1 10. The data storage apparatus of claim 1 wherein the storage element with  
2 at least one moving part is an optical drive.

1 11. The data storage apparatus claim 10 in the form of a disk storage  
2 subsystem for use with a personal or portable computer.

1 <sup>6</sup>  
2 ~~12.~~ The data storage apparatus of claim 1 wherein the storage element with  
at least one moving part is an magnetic disk drive.

1 <sup>7</sup>  
2 ~~13.~~ The data storage apparatus claim <sup>6</sup>~~12~~ in the form of a disk storage  
subsystem for use with a personal or portable computer.

1 <sup>8</sup>  
2 ~~14.~~ The data storage apparatus of claim 1 wherein the storage element with  
at least one moving part is an magnetoptical disk drive.

1 <sup>9</sup>  
2 ~~15.~~ The data storage apparatus claim <sup>8</sup>~~14~~ in the form of a disk storage  
subsystem for use with a personal or portable computer.

1 <sup>10</sup>  
2 ~~16.~~ The data storage apparatus of claim 1 wherein the solid state cache  
memory is non-volatile.

1 <sup>11</sup>  
2 ~~17.~~ The data storage apparatus claim <sup>10</sup>~~16~~ in the form of a disk storage  
subsystem for use with a personal or portable computer.

1 <sup>Sub A2</sup>  
2 ~~18.~~ Method for operating data storage apparatus having a storage element  
3 including at least one movable part, and solid-state cache memory in which the storage  
4 element is in a non-fully operational mode when data access has not occurred during a  
predetermined time period, the method comprising the steps of:

5 accessing data on the storage element in response to a read or write request  
6 which cannot be satisfied via access to the cache memory; and

7 transferring data between the cache memory and the storage element to  
8 maintain consistency of data therebetween, said data transfers between the cache

9

memory and the storage element are performed when after a read or write request has

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given rise to an access to the storage element.